Space Weather Technical Forecast

Issued on Friday, 03 May 2024 at 12:11 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further M-flares expected with a chance of X-flares through the period. G1/G2 intervals are likely over the weekend with a slight chance of G3 intervals.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is at High levels, due to an impulsive X1.7 flare at 03/0222UTC from AR3663, which also produced a further impulsive M4.4 flare at 03/0811UTC. Region AR3664 has also been active, producing two impulsive M-class flares in the past 24 hours. There are currently eight sunspot regions on the visible disc. Of these AR3663 and AR3664 are the largest and most complex, both with delta spots. AR3663 continues to develop, whilst AR3664 is now the most active region on the disc.

There are potentially three earth-directed CMEs currently analysed in the forecast. One from a CME that left the sun on the 29 April and may have been responsible for yesterdays unexpected CME arrival, if it wasn't the source it may give a glancing blow Day 1 (3rd May). The second left the sun around 01/0600 UTC and is expected to give a glancing blow late Day 2(4th May) or early Day 3 (5th May). Additionally an Earth directed CME associated with the X1.6 flare at 03/0222UTC may interact with Earth later Day 3 (5th May) although further analysis is required. A further CME may have occurred due to the M4.4 flare at 03/0811 UTC but due to lack of imagery this has not yet been analysed.

Solar Wind / Geomagnetic Activity: Solar winds observed by ACE at L1 were at background levels, between 340-370 km/s, until an unexpected CME arrived at 02/1310 UTC. Then the solar wind became slightly elevated for much of the evening, before become elevated from 03/0153UTC, peaking at around 540 km/s around 03/0419UTC. Density was mostly above average at first, with a peak at 28 ppcc at 02/1522 UTC, but fell to below average from 03/0200UTC. The Interplanetary Magnetic Field, Bt, started at moderate levels, then increased to Strong with a peak of 21nT at 02/1421 UTC, before falling back to moderate from 02/2130UTC and weak from 03/0145UTC. The north-south component, Bz, was mostly negative at first with the arrival of the CME the Bz reached -19 nT at 02/1354 UTC, before becoming briefly positive 02/1517-1618 peaking at 17.29nT, then becoming strongly negative again before rotating back to positive from 02/1900UTC. Phi angle was negative (towards the Sun), but rotated Positive (away from the sun) from 03/0245UTC. The resultant Geomagnetic activity was Unsettled (Kp 3) at first, then increased to reach G3/Strong (Kp 7) geomagnetic storm levels between 02/1500-2100 UTC, before falling to Quiet levels by 02/0300-0600.

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Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) observed at GOES18 was at background levels. High energy electron flux (greater than 2MeV) observed at GOES16 remained at background to moderate levels. The associated 24-hour fluence was well below the Active threshold. Observed fluence at 03/0001UTC was 7.49e6 integrated pfu, with a steady trend.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to high solar activity is expected to continue with further M-flares expected and a chance of isolated X-flares, principally from AR3663 and AR3664. As these two regions are still on eastern side of the disc, the flare risk is maintained throughout the period.

Solar Wind / Geomagnetic Activity: Uncertainty due to the source of yesterdays CME gives a risk of a glancing blow through Day 1 (3rd May). Another significant CME from 01/0600 UTC could impact Earth late on Day 2 (4th May) or early on Day 3 (5th May). An Earth-directed CME from the X1.6 flare on 03/0222 UTC may affected Earth on Day 3 but required further analysis.

CH33/+ could raise wind speeds later on Day 1, but more likely on Day 2, before declining through Day 4.

Geomagnetic activity is expected to be Unsettled to Active (Kp 3-4), with a chance of G1/Minor storm intervals on Day 1. From late Day 2 through Day 3, G1/Minor to G2/Moderate (Kp5-Kp6) storm intervals are likely due to the expected CMEs and HSS, with a slight chance of G3 (Kp7) intervals from a combination of these events. By late Day 4, geomagnetic activity should decrease to quiet to unsettled levels.

Energetic Particles / Solar Radiation: High energy proton flux is most likely to remain at background levels through this period. There is a slight chance for an S1/Minor Storm event, should any proton-rich flares occur initially from AR3654 and later from AR3663.

High energy electron flux is expected to remain at background to moderate levels, with associated fluence expected to remain below the Active (1e8 integrated pfu) threshold throughout.

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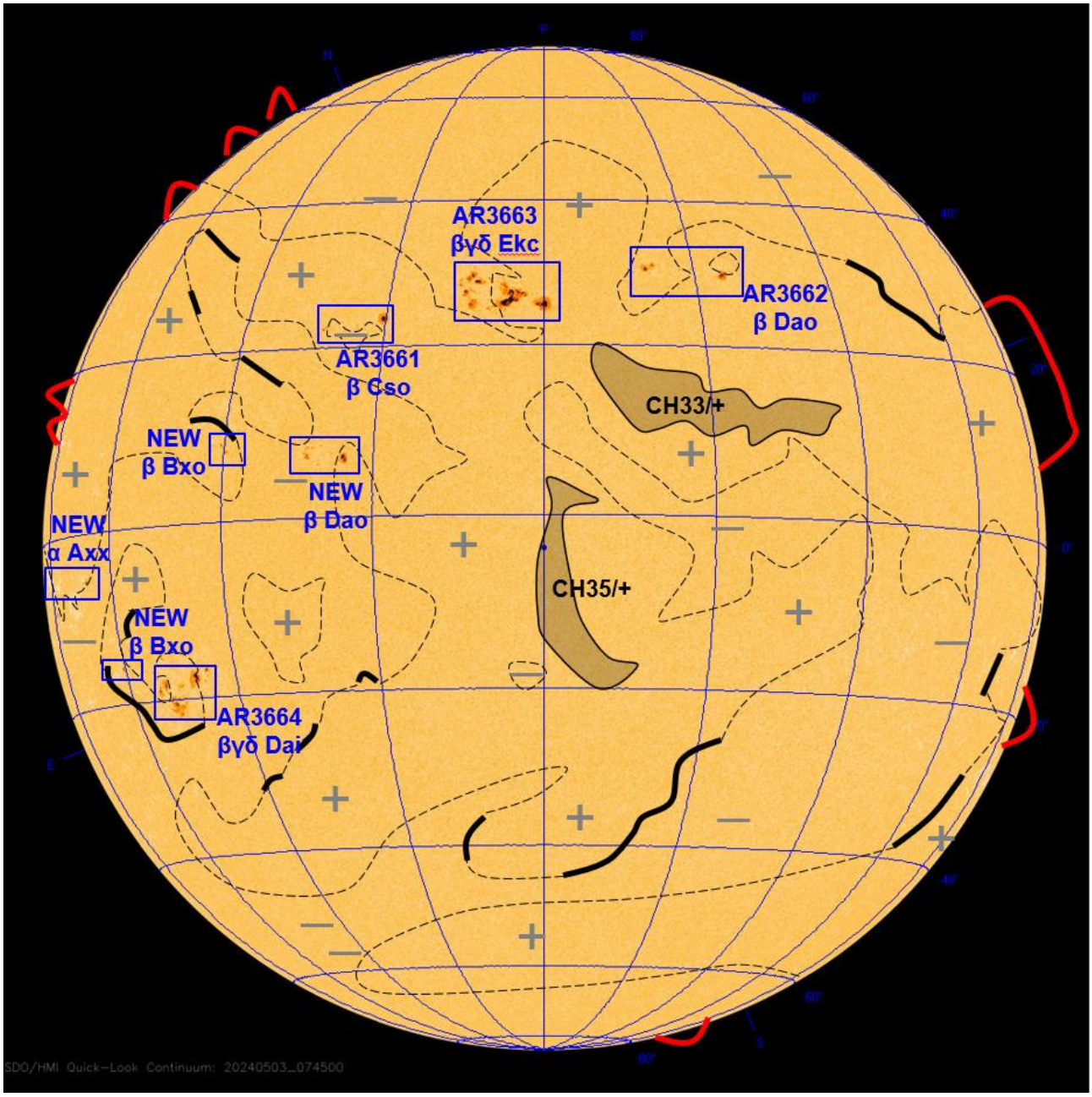
Figure 1. Solar Analysis Valid 03/0745UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME that left the sun on the 29th of April may have been responsible for the unexpected CME arrival at 02/1310UTC which is still giving slightly elevated solar wind speeds. If the CME from the 29th wasn't the source, there is still a chance it could give a glancing blow through Day 1 (3rd May). A more notable CME that left the Sun around 01/0600 UTC from the southwest disc is now expected to give a glancing blow either late Day 2 (4th May) or more likely early on day 3 (5th May). Additionally, an Earth directed CME associated with the X1.6 flare 03/0222UTC, may interact with Earth later on Day 3 (5th May), though initial analysis is uncertain due to limited imagery and will required further examination to improve confidence.

A HSS from CH33/+ may increase wind speeds later Day 1 (3rd May) or more likely Day 2 (4th May). This may cause wind speeds to become elevated and continue through Day 3 (5th May) before subsiding through Day 4 (6th May). CH33 is a slightly larger and more defined feature on this rotation, making persistence forecasting challenging.

Geomagnetic activity is expected to be largely unsettled to Active (Kp3-Kp4) for much of the period, due to a combination of residual CME influence, new CME arrivals and a HSS. Through Day 1 there is a chance of G1/Minor (Kp 5) geomagnetic storm intervals, with the continuing chance of a glancing CME blow and early onset of the HSS. From late Day 2 through Day 3, G1/Minor-G2/Moderate (Kp5-Kp6) geomagnetic storm intervals are likely due to the effects of the two aforementioned more probable CMEs and the HSS, with a slight chance of G3 intervals stemming from the interaction of these factors. By late Day 4 (6th May), geomagnetic activity is currently expected to decrease to quiet to unsettled levels.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	40	60	60	30
Strong	G3	Yes	5	20	20	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
01/1259	Partial	AR3654	SW	585	05/0000UTC	Glancing Blow
03/0646	Partial	AR3663	NE	900	05/1500UTC	Further analysis required

Figure 2: MOSWOC Enlil ensemble forecast

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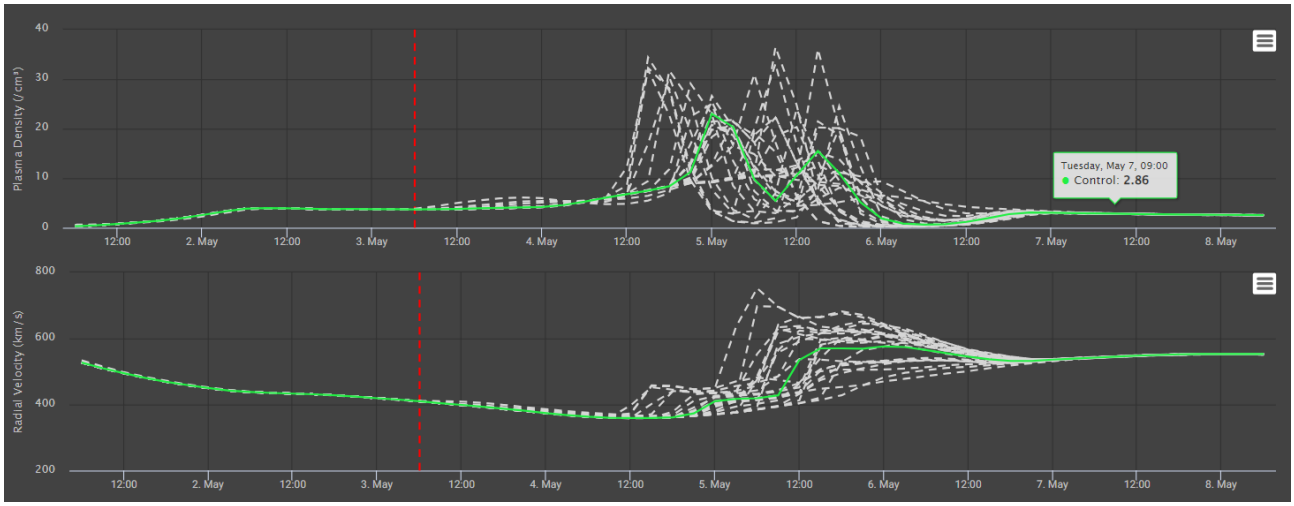

Radio Blackouts - X-Ray Flares:

There are currently eight sunspot regions on the visible disc, five of which are numbered, as AR3654 and AR3655 have rotated out of sight onto the west limb. AR3663 is currently the most active region on the visible disc, having produced the largest flare of the previous 24 hours, an X1.6 at 02/0222UTC and maintaining a delta spot, classified of Ekc/beta-gamma-delta. AR3664 is the second largest spot on the disc and is located in the southeast, it has produced two M-class flares in the past 24 hours and has a small, weak delta region in its leading spot, which has shown some minor recent growth. The largest unnumbered region, located in the northeast of the group has shown some recent enhancement and is now classified as a Dao/beta. The remainder of the spots on the disc are comparatively small and relatively magnetically stable.

Moderate to high solar activity is expected to continue with further M-flares expected and a chance of isolated X-flares, principally from AR3663 and AR3664. As these two regions are still on eastern side of the disc, the flare risk is maintained throughout the period.

There are limited signals in far-side helioseismographs for any significant oncoming regions in the coming days, but some smaller returning regions are expected and may contribute to the risk of significant flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	80	80	80
Very Active	R3 to R5 X Class	Yes	25	25	25	25

Figure 3: GOES 16/18 X-ray trace

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Solar Radiation Storms - (High Energy Protons):

High energy proton flux (greater than 10MeV) observed at GOES-18 has been at background levels and is most likely to remain that way through the period. However, there is a slight chance of an S1/Minor Storm event Day 1 (03rd May) or Day 2 (04th May) if any large, proton-rich flares from AR3654 just over the western limb. The slight chance of an S1/Minor Storm event returns Day 4 (06th May) once AR3663 reaches a more geoeffective position.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	10	5	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux is at background levels. Combined minor CME and coronal hole influences through the period are likely to maintain the electron flux to background to moderate levels throughout.

Overall, the 24 hour integrated electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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